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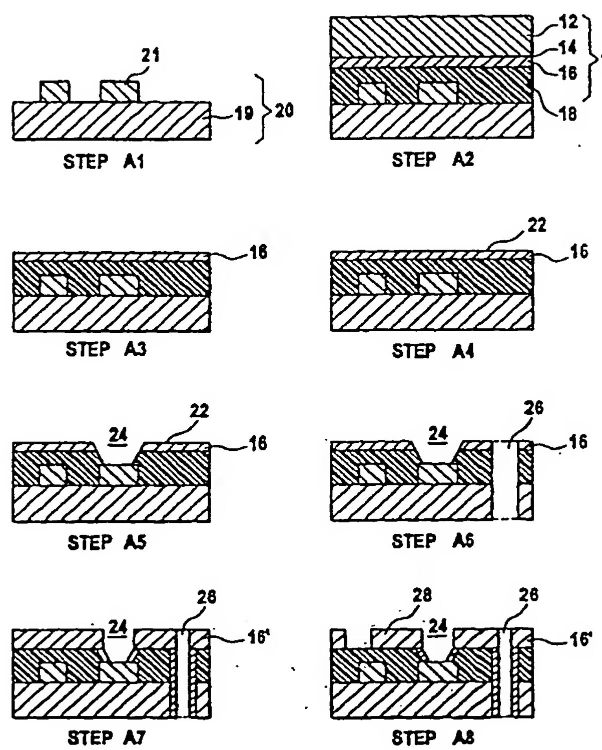
(54) Title: METHOD FOR MANUFACTURING A MULTILAYER PRINTED CIRCUIT BOARD AND COMPOSITE FOIL FOR USE THEREIN

(57) Abstract

A method for manufacturing a multilayer printed circuit board is disclosed. First a composite foil (10) including a functional copper foil (16) mounted on a carrier foil (12) is laminated on a core board (20). The functional copper foil (16) is less than 10 μm thick, and has a front side facing the carrier foil (12) and a back side coated with a resin (18). Next, the carrier foil (12) is removed from the functional copper foil (16), in order to uncover the front side of the functional copper foil (16). Then, a CO_2 laser source is used to drill holes through the functional copper foil (16) and the resin (18) in order to form microvias (24). It is also disclosed a composite foil (10) comprising four different layers for use in the manufacture of a multilayer printed circuit board.

Laser drilled
Via formation



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Method for manufacturing a multilayer printed circuit board and composite foil for use therein

The present invention generally relates to the manufacturing of a multilayer printed circuit board and to a composite foil for use therein.

The development of very compact and powerful electronic devices has been possible thanks to high-density printed circuit boards (PCB), obtained by sequential build-up (SBU) technology. Basically, a build-up multilayer circuit is a combination of several superimposed layers of different wiring densities, which are separated by dielectric layers and interconnected through micro blind vias with diameters of generally less than 100 μm.

Nowadays, essentially three different technologies are available for the manufacture of microvias: (1) the photochemical etching of photodielectrics; (2) the plasma etching process; and (3) the still relatively new process of laser drilling.

Laser drilling seems to be the most promising technology for the production of microvias. Excimer, Nd-YAG and CO_2 laser sources are currently used for drilling of microvias, but each of these laser sources still has its specific drawbacks. Excimer lasers are not considered economically viable for industrial use. They have a low ablation rate per pulse and involve high investments in safety precautions, as excimer laser gases are extremely corrosive and highly toxic. Nd-YAG lasers are successfully used for smaller and medium sized volumes of high end products with microvias of diameters from 25 to about 75 μm. Larger holes must be produced by trepanning (i.e. by drilling multiple smaller holes), which of course reduces drilling speeds considerably. CO_2 lasers are increasingly gaining ground vis-à-vis the Nd-YAG laser for a large volume production of microvias. They are characterised by an ablation rate in non-reinforced polymer that is about twenty times as high as for Excimer or Nd-YAG lasers.

However, if CO_2 lasers are very much adapted for polymer ablation, they are not suitable for copper removal. Hence, an additional process step, the manu-

facturing of a conformal mask, is necessary before a hole can be produced in the dielectric layer with the CO_2 laser. During this additional step, openings are etched in the copper laminate at the positions where the dielectric should be removed later. This method allows to use the CO_2 laser for drilling blind micro-vias, but the manufacturing process is slowed by the conformal mask building step and there is a real risk of damaging the copper layer during the conformal mask building.

In order to avoid the above and other disadvantages of the conformal mask technology, it has been suggested to use a twin laser device for drilling the holes. Such a twin laser device is a combination of CO_2 laser source with an IR solid-state laser. First, the opening in the copper foil is carried out with the solid-state laser. The resin layer is then removed with the CO_2 laser. Such a twin laser allows microvia drilling in copper cladded build-ups, but the investment cost is higher than for a simple CO_2 laser, and the slow copper drilling step is responsible for a low process speed.

It has also been suggested to replace the manufacture of the conformal mask by a "half etching" step. A thin resin coated copper foil of about 18 μm is first laminated on the core board, with its copper foil upside. After lamination, the 18 μm copper foil is etched over its entire surface, in order to reduce its thickness down to about 5 μm. In the next step, the copper layer undergoes a black oxide treatment, to form a laser drilling adapted surface. Then, the CO_2 laser is used to drill the microvias directly through the 5 μm copper layer and the subjacent resin layer. The "half etching" step is of course less complex than conformal mask building, but the manufacturing process is nevertheless slowed down by the half etching step and the copper surface might still be damaged during the half etching step. Furthermore, CO_2 laser drilling on "half etched" copper foils does not yet produce satisfying results. The poor results are due to the fact, that etching the entire surface of e.g. a 600 mm x 500 mm printed circuit board is neither a homogeneous, nor a precise operation. The most recent etching agents and etching machines claim a tolerance of ± 2 μm. The thickness of a copper foil etched down to a nominal thickness of 5 μm may therefor vary from

3 µm to 7 µm. When drilling the microvias, the laser energy is set for a nominal copper thickness of 5 µm. If the copper layer at the incidence point is only 3 µm, the set laser energy is too high for the amount of copper to be vaporised. As a result, copper splashes are created on the border of the hole and the hole in the dielectric material is generally misshaped. If the copper layer at the incidence point is however 7 µm, the set laser energy is too low and the resulting hole in the dielectric material will have too small a diameter or will even not extend to the subjacent copper layer. Due to the disappointing results of the half etching method, CO_2 laser drilling is still exclusively used on non-copper cladded build-up materials or with conformal mask etching.

Consequently, there is a strong need for a simple and efficient method for the manufacture of printed circuit boards, which allows fast laser drilling of high-quality microvias. According to the present invention, this object is achieved by a method according to claim 1.

Another object of the present invention is to provide a composite foil, which allows fast laser drilling of high-quality microvias, when it is used in the manufacture of printed circuit boards. According to the present invention, this object is achieved by a composite foil according to claim 14.

In accordance with the present invention, a method for manufacturing a multi-layer printed circuit board comprises the following steps:

a) providing a core board;

b) providing a composite foil including a functional copper foil mounted on a carrier foil, said copper foil having a front side facing said carrier foil and a back side coated with a resin;

c) laminating said composite foil with the resin coated back side on one side of said core board;

d) removing said carrier foil from said functional copper foil, in order to uncover said front side of said functional copper foil;

e) drilling holes through said functional copper foil and said resin in order to form microvias.

According to an important aspect of the present invention, the functional copper foil of the composite foil has a thickness of less than 10 µm, preferably of about 5 µm, whereby it becomes possible to use a CO_2 laser source to drill microvias directly from the uncovered front side through the very thin functional copper foil and the subjacent dielectric layer. It follows that "half etching" or "conformal mask building" steps are no longer necessary, so that the manufacturing process of a multilayer PCB gets simpler. The simplicity of the process enables high speed processing and high productivity, with less process equipment and therefore lower investment costs. In other words, the process of manufacturing gets more efficient. Consumption of chemical etching agents is also substantially reduced. This is of course an important feature with regard to environmental protection. With regard to quality control, it will be noted that the thin functional copper foil has an accurate thickness and a controlled and homogenous surface profile and roughness, so that the CO_2 laser beam encounters similar and reproducible drilling conditions everywhere. It follows that the laser energy can be set to drill very precise microvias everywhere on the PCB, i.e. microvias having a well determined shape, diameter and height, without producing copper splashes on the copper surface. It will further be appreciated that the carrier provides the necessary rigidity for handling the functional resin coated copper foil. Moreover, the latter is protected between its carrier and its resin coating against particles, chemical agents or atmospheric agents, that may damage the surface integrity, and alter the future circuit pattern. Due to the self supporting carrier foil, not only the very thin functional copper foil, but also the rather brittle resin coating is protected against tears, cracks and wrinkles. During lamination, the carrier provides an efficient protection of the very thin functional copper foil against dust and particles (as e.g. resin particles), which may indent the surface, and against resin bleed-through. After removal of the carrier, the functional copper layer is consequently clean and free of any defects such as e.g. indentations, tears, cracks and wrinkles.

The functional copper foil is preferably obtained by electro-deposition. Advantageously, the front side of the functional copper foil has received a surface preparation favouring the absorption of CO_2 laser light. Such a surface prepara-

tion may e.g. provide a front side having a particular surface profile and roughness and/or a colour favouring the absorption of CO_2 laser light. It can take place during manufacturing of the composite copper foil, so that the functional copper foil is ready for laser drilling after removal of its carrier. The front side of the functional copper foil may also be covered prior to laser drilling with a black oxide conversion coating, thus favouring the absorption of CO_2 laser light.

It will be noted that the composite foil preferably includes a release layer intermediate the carrier foil and the functional copper foil. Such a release layer may simply permit the separation of the carrier foil, like e.g. a thin, chromium based release layer. In this case, the carrier removal then normally consists in mechanically peeling off the carrier foil and the release layer simultaneously, i.e. the release layer remains bonded to the carrier foil. However, another kind of release layer may remain on the functional copper foil instead of the carrier foil when removing the carrier foil, and exhibit a particular surface colour favouring the absorption of CO_2 laser light. Such a kind of release layer, having a dual function, may be a dark coloured conductive material layer and should allow copper electroplating to form the functional copper foil thereon, show a strong adhesion to the functional copper foil, and have a colour favouring the absorption of the infrared light of a CO_2 laser.

In a first embodiment, the resin is a B-staged resin. It can therefore adapt to the subjacent circuits of the core board, and the polymerisation is completed during lamination.

In a second embodiment, the resin coating on the back side consists of a C-staged resin layer applied to the back side of the functional copper foil, and of a B-staged resin layer applied to said C-staged resin layer. The insulating layer is therefore thicker and can still adapt to the subjacent circuit layer.

It will be appreciated that the present invention also provides a composite foil for use in a method for manufacturing a multilayer printed circuit board, comprising a self-supporting carrier foil, preferably a copper foil with a thickness from 18 to 150 μm; a release layer on one side of the carrier foil; a functional copper foil, having preferably a thickness of less than 10 μm, most preferably of

about 5 µm, the functional copper foil being deposited on the release layer and having a front side facing the release layer and a back side; and a resin coating on the back side of the functional copper foil.

The front side of the functional copper foil has preferably received a surface preparation favouring the absorption of CO_2 laser light. Such a surface preparation may be carried out by forming a dark coloured conductive material layer between the release layer and the functional copper foil. In a first embodiment of the composite copper foil of the invention, the dark coloured conductive material layer may comprise carbon black and/or graphite. In a second embodiment, the dark coloured conductive material layer may comprise a dark coloured electrically conductive polymer layer.

It shall be noted that the release layer may itself be a dark coloured conductive material layer, thereby exhibiting a dual function of release layer and surface preparation favouring the absorption of CO_2 laser light. The composite foil would then comprise a carrier foil, this release layer having a dual function, a functional copper foil, and a resin coating. It is clear that such a release layer, contrary to a conventional release layer like e.g. a chromium release layer, has to adhere to the front side of the functional copper foil when removing the carrier foil.

Advantageously, the back side of the functional copper foil has a bonding layer thereon so as to improve its bond strength with the resin coating. Moreover, the functional copper foil may be covered with a passivation layer, preferably intermediate the bonding layer and the resin coating, in order to warrant the stability of the back side.

The present invention will be more apparent from the following description of a not limiting embodiment with reference to the attached drawings, wherein

Fig.1: is a cross-sectional S.E.M.-view of a composite foil used for the manufacturing of a multilayer printed circuit board; and

Fig.2: is a diagram showing the process steps of the manufacturing of a multilayer printed circuit board.

The present method uses a composite foil 10, more precisely a resin-coated carrier-mounted copper foil for building a multilayer PCB. Figure 1 shows a Scanning Electron Microscope view of such a composite foil, which will be laminated on a core board. It comprises four different layers: a carrier foil 12; a release layer 14; a functional copper foil 16; and a resin coating 18. Such a composite foil is the result of two subsequent manufacturing processes.

The first process is similar to the process described in US 3,998,601. First, a 70 μm carrier foil 12 is produced from an acid based electrolyte by continuous electro-deposition on a rotating titanium drum that has a precisely engineered surface. The drum surface topography prescribes and controls the initial layer of copper deposited. The topography of the other side, the matte side, of the carrier layer is controlled by the additives in the basic drum copper electrolyte. In a further step the release layer 14 is applied to one surface of the carrier foil 12, providing very closely controlled, but relatively low adhesion characteristics. The release layer 14 has a very thin thickness, typically less than 1 μm. The functional copper foil 16 is electrodeposited onto the release layer 14 with a thickness of preferably 5 μm. The side of the functional copper foil 16 facing the carrier foil 12, called hereinafter the front side, is consequently a mirror image of the surface of the carrier foil 12 which is covered with the release layer 14. It follows that acting on the structure of the surface of the carrier foil 12 which is covered with the release layer 14 enables to provide a particular surface profile and roughness to said front side of the functional copper foil 16. The other side of the functional copper foil 16, hereinafter called the back side, is a matte side. This back side undergoes a series of chemical and electrochemical treatments, that will define some functional characteristics, such as bond strength with regard to the resin coating and stability with regard to corrosion. Hence a bonding layer, obtained by electrodeposition of copper nodules, is formed on the back side of the functional copper. Then a passivation layer is applied over the bonding layer. It may be noted that a passivation layer may also be applied over the exposed side of the carrier foil 12, i.e. not bearing the release layer 14, in order to avoid the formation of a "blue oxidation frame" during PCB manufacturing, e.g. in a press.

In the following process, the composite copper foil 12, 14, 16 is processed in a coating machine, where the back side of the functional copper foil 16, already covered by the bonding layer and the passivation layer (not shown on the Figures), is coated with a non-reinforced thermosetting preferably semi-polymerised (B-staged or semi-cured) resin. The use of a B-staged resin is very convenient when the composite foil is laminated on a core board. Indeed, since the resin is only semi-polymerised, it can adapt to the subjacent topography of the outer layer circuits of the core board. On top of that, the polymerisation of the B-staged resin can be finished (leading to C-staged resin) during lamination since it is e.g. carried out in a hydraulic press or in an autoclave with heating and cooling cycles.

The resinous coating 18 may also comprise two superimposed layers. One first thin layer (25-45 μm) of C-staged resin is applied on the functional copper layer, and a second layer of semi-cured resin is applied over the precedent one. This way of processing achieves a thick resinous coating and is much easier and safer than applying a single layer of B-staged resin having the same thickness. It is of course also possible to apply more than two resin layers in order to reach the desired thickness.

Figure 2 illustrates a preferred manufacturing process of a multilayer printed circuit board in accordance with the present invention.

The process starts in step A1 with the provision of a finished core board 20. The core board 20 shown in Fig. 2 consists e.g. of a one-sided copper-cladded prepreg 19, where circuit patterns 21 have already been etched into the copper clad. The circuit patterns 21 are preferably surface treated by oxidation or roughening, in order to achieve a higher bonding strength with the subsequent overlying dielectric material.

In step A2, a composite foil 10, obtained as described hereinbefore, is laminated on one side of the core board 20, wherein the resin coating 18 of the composite foil 10 faces the circuit patterns 21 on the core board 20. This lamination takes place in a hydraulic press and involves preferably several cooling and heating cycles. During the lamination step, the polymerisation of the

B-staged thermosetting resin is completed. It shall be remarked that a greater dielectric thickness can be obtained by placing an interlaminar dielectric sheet between the core board 20 and the composite foil 10 before lamination.

Once the lamination is finished and the resin 18 is fully polymerised, step A3 takes place, i.e. the carrier foil 12 and the release layer 14 are mechanically peeled off. The very thin release layer 14 remains bonded to the 70 µm copper carrier foil 12, leaving an atomically clean, homogeneous and defect free functional copper layer 16 on top of the core board 20.

In step A4, the functional copper foil 16 preferably undergoes a surface treatment, in order to prepare its front side for direct CO_2 laser drilling. This surface treatment may consist in the deposition of a black oxide conversion coating 22 on the functional copper foil 16. The black oxide conversion coating warrants indeed an efficient CO_2 laser drilling, because it reduces laser light reflection on the uncovered copper surface. It will be understood the black oxide conversion coating may be replaced by any laser drilling adapted oxide conversion coating, such as for example a brown oxide conversion coating.

Step A5 consists in drilling micro blind vias 24 into the functional copper foil 16 and the resin layer 18, so as to reach underlying copper pads, for future interconnection of the functional copper foil 16 and the circuit patterns 21 on the core board 20. It will be appreciated that the microvias are drilled directly with a CO_2 laser source in one step through the functional copper foil 16 and the resin coating 18. CO_2 laser sources emit light in the infrared range with a wavelength between 9.4 and 10.6 µm. Such infrared wave lengths are not well suited for copper ablation, but—due to its small thickness and its specific surface treatment—the functional copper foil 16 is nevertheless pierced without difficulties by the CO_2 laser beam. Once the very thin copper layer is removed, the CO_2 laser fully develops its advantages. Over 90% of the laser radiation is then absorbed by the underlying dielectric material, up to a depth which is several times the wavelength. This results in very high ablation rates per laser pulse and therefore a high drilling speed. It remains to be said that material ablation with a CO_2 laser is based on a photothermal process. The laser radiation is absorbed by

the material to be removed, which is vaporised and driven out of the interaction zone through a resulting overpressure. Once the lower target pad is uncovered, the laser radiation is almost completely reflected by this target pad and material removal is thereby stopped automatically.

Next, in step A6, through-holes 26 are mechanically drilled into the PCB. It shall be noted that this step is optional, as will be explained later.

Step A7 is a combination of four sub-steps:

- the PCB is firstly cleaned with high pressure water;
- the PCB subsequently undergoes a complete removal of the black oxide conversion coating and a desmearing process which warrants the removal of all the residues from the CO_2 laser ablation;
- then copper is firstly deposited by electroless plating in the microvias, the through holes and over the whole PCB.
- finally galvanic reinforcement, i.e. copper electrodeposition, is preferably carried out until the outer copper layer 16' reaches e.g. a thickness of about 18 μm.

During step A8, the outer copper layer 16', which has now a thickness of preferably 18 μm, is etched in order to form circuit patterns 28 on the outer surface. The Circuit patterns may be etched during step A7 before the electroless plating and galvanic reinforcement, the method subsequently finishing at the end of step A7.

It should be noted that step A4 (i.e. deposition of the black oxide conversion coating) of the process of Fig.2 can be suppressed, when using a composite foil having a functional copper foil, the front side of which is prepared for laser drilling during manufacturing. Indeed, the front side is typically a shiny side which reflects the CO_2 laser beam; the black oxide conversion coating avoids such reflection, thus causing the CO_2 laser beam to heat the copper surface, enabling material ablation. Another way of avoiding reflection of the CO_2 laser beam is to obtain, during the manufacturing of the composite foil, a non-reflecting front side. The front side can be characterised by its colour and its

matteness. In that respect, the front side characteristics should be prepared in order to provide a surface profile and roughness favouring the absorption of CO_2 laser light. The front side should also undergo a surface preparation so as to form a front side having a colour favouring the absorption of CO_2 laser light.

Such a surface preparation taking place during manufacturing comprises for example the step of providing a thin layer of dark coloured electrically conductive material on the release layer before electrodepositing the functional copper foil. When the carrier foil and the release layer are peeled-off, the thin layer of dark coloured electrically conductive material adheres to the front side of the functional copper foil and thereby provides a dark coloured layer on this front side. It will be noted that such a thin layer of dark coloured electrically conductive material must adhere to the release layer, allow copper electroplating to form the functional copper foil thereon, show a stronger adhesion to the functional copper foil than to the release layer, and have a colour favouring the absorption of the infrared light of a CO_2 laser.

Besides, it will be understood that such a thin layer of dark coloured electrically conductive material may play the role of release layer itself and of course that of the surface preparation favouring the absorption of CO_2 laser light. Thus, the composite foil would comprise a carrier foil, a release layer of dark coloured electrically conductive material, a functional copper foil and a resin coating. It is clear that the release layer should then necessary remain on the front side of the functional copper foil when peeling off the carrier foil.

A first candidate for forming such a dark coloured electrically conductive material layer is carbon. A substantially continuous layer of carbon can be obtained by carbon deposition. Carbon deposition may comprise the application of a liquid carbon dispersion to the side of carrier foil, possibly covered with a chromium based release layer, which will be facing the functional copper foil. Generally, the carbon dispersion contains three principal ingredients, namely carbon, one or more surfactants capable of dispersing the carbon, and a liquid dispersing medium such as water. Many types of carbon may be used including the commonly available carbon blacks, furnace blacks, and suitable small

particle graphites. The average particle diameter of the carbon particles, should be as small as possible to obtain even plating. The carbon particles may be treated before or after deposition in order to enhance or improve the electroplating. Therefore, the carbon particles can be treated with particular dyes, particular conductive metals, or chemically oxidised.

Example: in order to produce a composite copper foil having a functional copper foil with a front side prepared for laser drilling, there was provided a 35 µm thick carrier foil made of copper. A chromium release layer was conventionally (as described in US 3,998,601) electrodeposited on one side of the carrier foil. Then, as explained above, a thin (15-25 µm), conductive layer containing carbon black and/or graphite, i.e. the dark coloured electrically conductive material layer, was formed onto the chromium plated side of the carrier foil. The carbon paste was Carbon-Leitlack SD 2841 HAL-IR (Lackwerke Peters, D-47906 Kempen). The carbon layer was dried by use of infrared light, and a 5 µm thick functional copper foil was subsequently electrodeposited on the carbon coated side of the carrier foil. The electrodeposition of the functional copper foil was carried out in an electroplating bath comprising 60 to 65 g/l of copper sulfate (as Cu^{2+}) and 60 to 65 g/l of sulfuric acid. The current density was 11 A/dm^2 and the temperature of the electroplating bath was 60°C. Next, a nodular treatment was applied to the outer side of the functional copper foil. This foil was subsequently laminated on a conventional glass-epoxy FR4 prepreg (Duraver -E-104 from Isola werke AG, D-52348 Duren) at 175°C for 80 minutes using a pressure of 20-25 bar. After cooling down to room temperature, the carrier foil was manually peeled off. As a result, there was obtained a black coating on the 5 µm thick, functional copper foil, which required no further surface preparation before CO_2 laser drilling.

A second candidate for forming the dark coloured electrically conductive material layer is a dark coloured electrically conductive polymer. Indeed, some monomers, such as pyrrole, furan, thiophene and some of their derivatives, and namely functionalised monomers, are capable of being oxidised into polymers that are electrically conductive. Such a monomer is preferably applied to the

surface of the release layer by a wet process, i.e. in a liquid or aerosol form. The monomer is thereafter polymerised, and the functional copper foil is subsequently deposited over the polymer layer. It will be understood that, when applied to the side of the carrier foil, possibly covered with a release layer, that will be facing the functional copper foil, the monomer can be part of a precipitation solution also containing at least a solvent. The precipitation solution might also contain one additive increasing the darkness of the polymerised monomer.

If the composite foil has a chromium based release layer and a dark coloured electrically conductive material layer, then the release layer may be treated during manufacturing of the composite foil to avoid a too strong adhesion of the carbon layer or the dark coloured electrically conductive polymer layer thereon. The adherence of those layers to the front side of the functional copper foil is thereby ensured, which is desirable when the carrier foil and the release layer are peeled off at step A3.

It shall be noted that the method presented herein has been described for a single sided core board, but is also applicable with a double-sided core board, the different steps being subsequently performed on both surfaces. The composite foil 10 could also comprise a 35 µm carrier foil 12 instead of a 70 µm carrier foil 12.

It remains to be noted that a PCB generally comprises several outer layers. Hence, the PCB of step A8 may serve as core board in the above described manufacturing method, so as to add outer layers thereon. However, it will be understood that step A6 is not necessary to pass from step A5 to step A7, and was therefore termed optional. Indeed, the mechanical through hole drilling – when required– generally only occurs when manufacturing the very last outer-layer of the PCB. In other words, the PCB obtained at step A8 after a first run of the manufacturing method may not have a mechanically drilled through hole. It is also clear that, for the first run of the process, the core board 20 at step A1 may already be a one-sided or double-sided PCB consisting of several layers.

A last remark concerns the formation of the functional copper foil. In the present description, the functional copper foil 16 was electrodeposited on the release

layer or on the dark coloured electrically conductive material layer. The functional copper foil could also be formed independently –e.g. by electrodeposition– and then placed over the release layer or dark coloured electrically conductive material layer. Another alternative, however onerous, is to start the formation of the thin functional foil on the release layer or dark coloured electrically conductive material layer with a CVD or PVD process, and to subsequently grow the obtained copper layer to the desired thickness by galvanic reinforcement.

Claims

1. A method for manufacturing a multilayer printed circuit board comprising the following steps:

   a) providing a core board (20);

   b) providing a composite foil (10) including a functional copper foil (16) mounted on a carrier foil (12), said functional copper foil (16) having a front side facing said carrier foil (12) and a back side coated with a resin;

   c) laminating said composite foil (10) with the resin coated back side on one side of said core board (20);

   d) removing said carrier foil (12) from said functional copper foil (16), in order to uncover said front side of said functional copper foil (16);

   e) drilling holes through said functional copper foil (16) and said resin in order to form microvias;

   characterised

   in that said functional copper foil (16) has a thickness of less than 10 μm; and

   in that a CO_2 laser source is used to drill said holes from said uncovered front side through said functional copper foil (16).

2. The method as claimed in claim 1, characterised in that said functional copper foil (16) is electrodeposited and has a thickness of about 5 μm.

3. The method as claimed in claim 1 or 2, characterised in that said front side of said functional copper foil (16) has received a surface preparation favouring the absorption of CO_2 laser light.

4. The method as claimed in claim 3, characterised in that said surface preparation provides a particular surface profile and roughness favouring the absorption of CO_2 laser light.

5. The method as claimed in claim 3 or 4, characterised in that said surface preparation provides a particular surface colour favouring the absorption of CO_2 laser light.

6. The method as claimed in claim 3, 4 or 5, characterised in that said surface preparation takes place during manufacturing of said composite foil (10).

7. The method as claimed in any one of claims 1 to 6, characterised in that said front side of said functional copper foil (16) is covered with a black oxide conversion coating prior to laser drilling.

8. The method as claimed in any one of the preceding claims, characterised

   in that said composite foil (10) further includes a release layer (14) intermediate said carrier foil (12) and said functional copper foil (16); and

   in that said carrier foil (12) removal of step d) consists in mechanically peeling off the carrier foil (12) and the release layer (14) simultaneously.

9. The method as claimed in any one of claims 1 to 6, characterised

   in that said composite foil further includes a release-layer intermediate said carrier foil and said functional copper foil, said release layer having a particular surface colour favouring the absorption of CO_2 laser light; and

   in that when removing said carrier foil at step d), said release layer remains on said front side of said functional copper foil.

10. The method as claimed in any one of the preceding claims, characterised in that said resin comprises a layer of B-staged resin.

11. The method as claimed in any one of the preceding claims, characterised in that said resin layer comprises a C-staged resin layer applied on the back side of the functional copper foil (16), and a B-staged resin layer applied on said C-staged resin layer.

12. The method as claimed in any one of the preceding claims, characterised in that after step e) copper is deposited by electroless plating over the functional copper foil (16).

13.The method as claimed in claim 12, characterised by a subsequent galvanic reinforcement step, wherein copper is electrodeposited over the functional copper foil (16) in order to increase its thickness.

14.A composite foil for use in a method for manufacturing a multilayer printed circuit board, comprising:

a carrier foil (12);

a release layer (14) on one side of said carrier foil (12) ;

a functional copper foil (16) deposited on said release layer (14), said functional copper foil (16) having a front side facing said release layer (14) and a back side; and

a resin coating (18) on said back side of said functional copper foil (16);

characterised

in that said functional copper foil (16) has a thickness of less than 10 µm; and

in that said front side of said functional copper foil (16) has received a surface preparation favouring the absorption of CO_2 laser light.

15.The composite foil as claimed in claim 14, characterised in that said front side has a particular surface profile and roughness favouring the absorption of CO_2 laser light.

16.The composite foil as claimed in claim 14 or 15, characterised in that said front side has a particular surface colour favouring the absorption of CO_2 laser light.

17.The composite foil as claimed in claim 14, 15 or 16, characterised in that said functional copper foil (16) is electrodeposited on said release layer (14) and has a thickness of about 5 µm.

18.The composite foil as claimed in claim 16, characterised in that said surface colour is obtained by forming a thin layer of dark coloured electrically conductive material between said release layer (14) and said functional copper foil (16).

19. The composite foil as claimed in any one of claims 14 to 18, characterised in that said carrier foil (12) has a thickness between 18 and 150 µm, said release layer (14) has a thickness of less than 1 µm, and said resin coating (18) has a thickness between 5 and 150 µm.

20. The composite foil as claimed in any one of claims 14 to 19, characterised in that said release layer (14) is a chromium based layer.

21. The composite foil as claimed in claim 16, characterised

in that said release layer remains attached to said front side of said functional copper foil when said carrier foil is removed; and

in that said release layer has a particular surface colour favouring the absorption of CO_2 laser light.

22. The composite foil as claimed in claim 21, characterised in that said release layer is a thin layer of dark coloured electrically conductive material.

23. The composite foil as claimed in claim 18 or 22, characterised in that said thin layer of dark coloured electrically conductive material is a layer comprising carbon black and/or graphite.

24. The composite foil as claimed in claim 18 or 22, characterised in that said thin layer of dark coloured electrically conductive material is a layer comprising a dark coloured electrically conductive polymer.

25. The composite foil as claimed in claims 14 to 24, characterised by a bonding layer on said back side of said functional copper foil (16).

26. The composite foil as claimed in claims 14 to 25, characterised by a passivation layer on said back side of said functional copper foil (16), preferably intermediate said bonding layer and said resin coating (18).

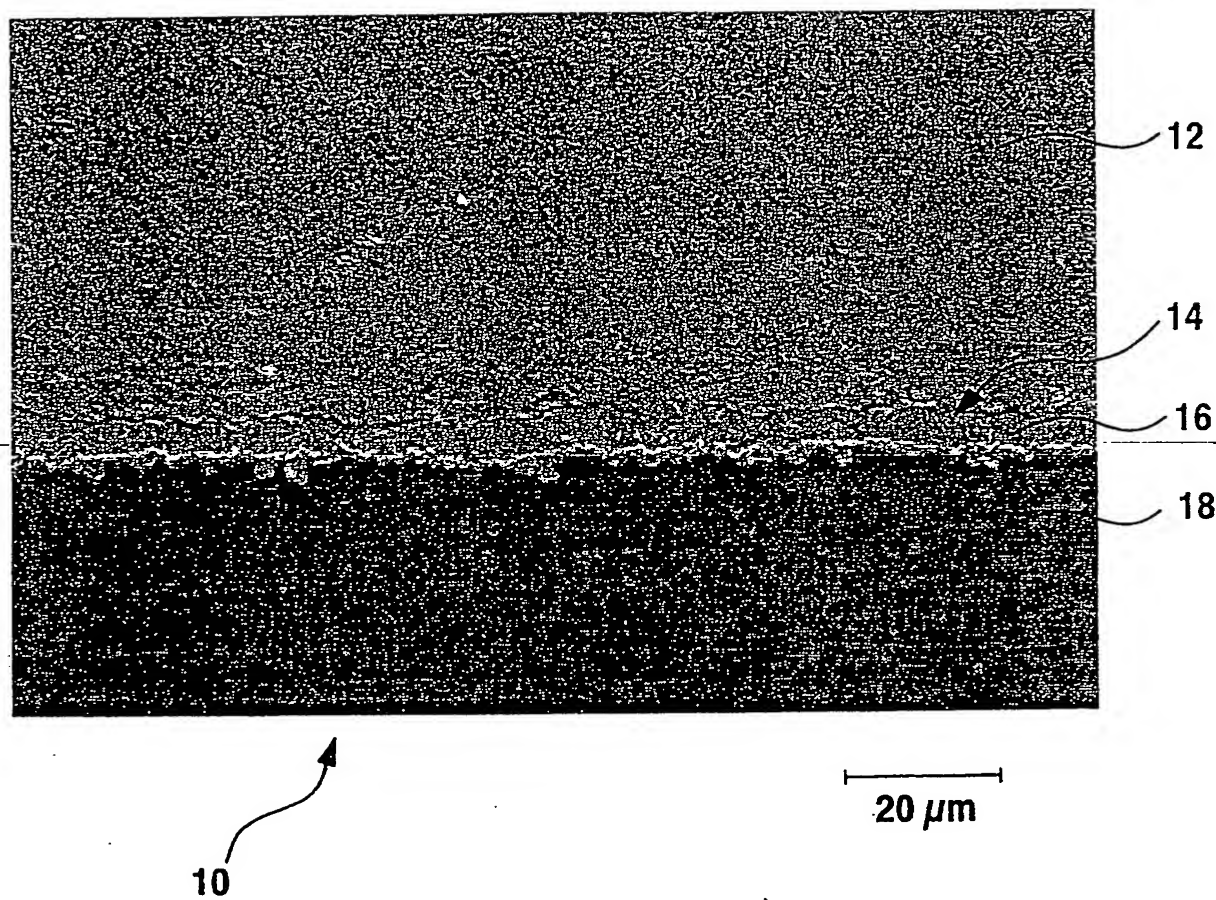

Fig.1

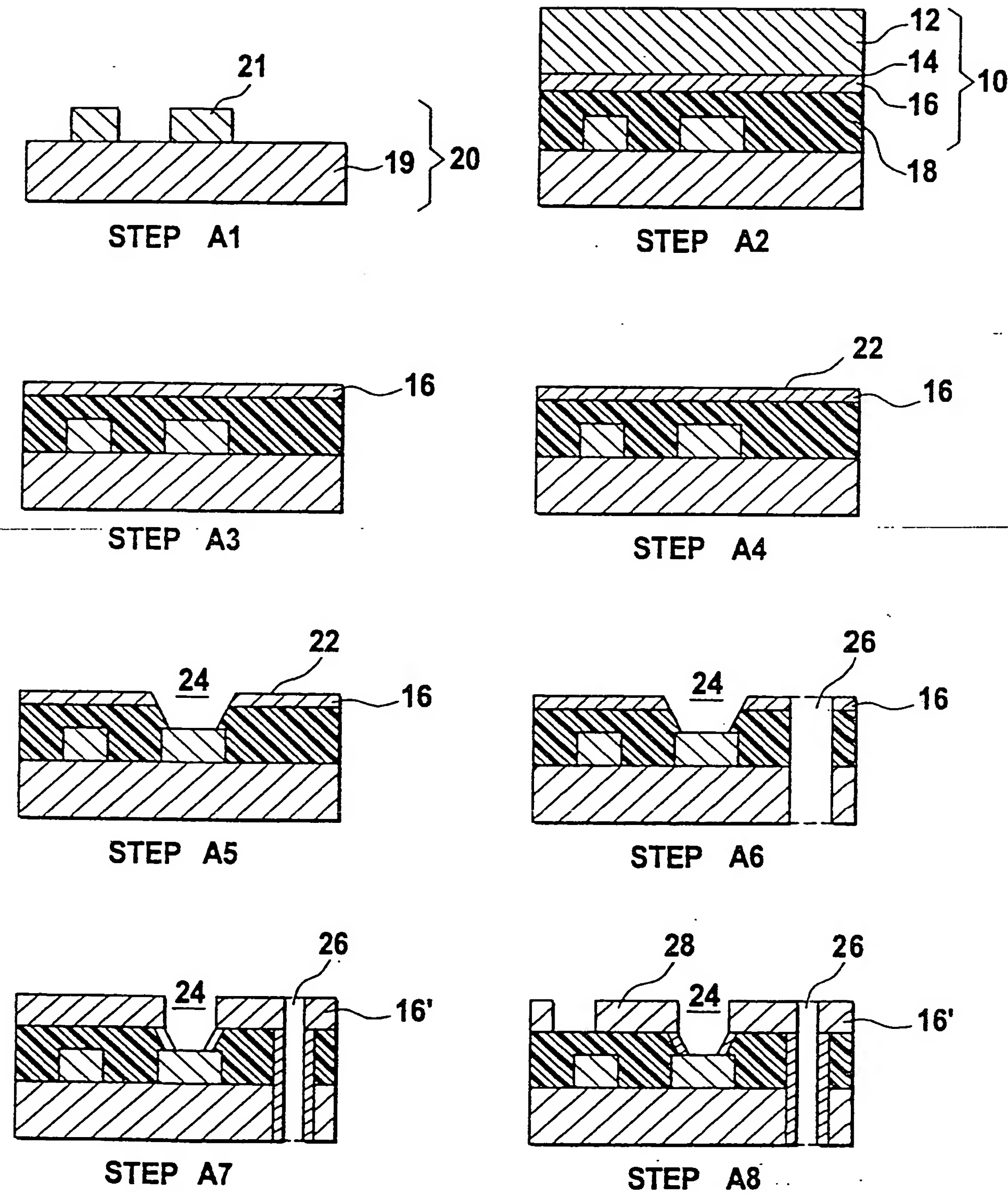

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Fig. 2

INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/EP 00/02560

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05K3/46 H05K3/02 H05K3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 July 2000	13/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mes, L

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/02560

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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